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Report No. 8926-154

Material - Welding Electrodes - P&H BA91 (Harnischfeger Corporation)

Weld Strength After Heat Treatment

A. Guintoli, H. C. Turner, W. M. Sutherland

12 May 1958

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(Harnischfeger Corporation)

Weld Strength After Heat Treatment .

Abstract:

Single groove, vee-joint butt welds with a 1/8 inch root spacing were made in 1/8 inch thick, annealed 4340 steel using P&H BA91 (Harnischfeger Corporation) welding electrodes for two pass, reverse polarity, DC welding. After welding the weldments were normalized (1600°F, 1-1/2 hours, air cool), austenitized (1550°F, 1-1/2 hours, oil quench) and double tempered (800°F, 2 hours, air cool, 800°F, 2 hours, air cool). The ultimate strength of the heat treated parent material was 182.0 KSI, and of the welds 170.9 KSI (10 specimens). The weld efficiency thus was 94%.

Reference: Guintoli, A., Turner, H. C., Sutherland, W. M., "Mechanical Properties of 4340 Steel Welded with P&H BA91 Welding Rod," General Dynamics/Convair Report MP 57-931, San Diego, California, 12 May 1958. (Reference attached).

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A DIVISION OF GENERAL DYNAMICS CORPORATION
SAN DIEGO

STRUCTURES-MATERIALS LABORATORIES

REPORT 57-931
DATE 5-12-58
MODEL REA 8211

TITLE

MECHANICAL PROPERTIES OF SAE 4340 STEEL WELDED WITH P&H - BA91 WELDING ROD

REPORT NO. 57-931

MODEL: REA 8211

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E. F. Strong,
Chief of Test Laboratories

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NO. OF DIAGRAMS 2

REVISIONS

NO.	DATE	BY	CHANGE	PAGES AFFECTED

FORM 1618A-4

ACCESS NO.

Title: MATERIAL - WELDING ELECTRODES - P&H BA91 (HARNISCHFEGER CORPORATION). WELD STRENGTH AFTER HEAT TREATMENT.

Authors: Guintoli, A., Turner, H. C., Sutherland, W. M.
Report No: 8926-154 Date: 12 May 1958
Contract: R.E.A. 8211
Contractor: General Dynamics/Convair
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4 pages, 1 table, 2 figures.

REPORT #57-931

Mechanical Properties of SAE 4340 Steel Welded with P&H - BA91 Welding Rod

OBJECT:

To determine joint efficiency of heat treated SAE 4340 steel welded with P&H - BA91 welding rod.

CONCLUSIONS:

Weld joint made with P&H - BA91 welding rod in SAE 4340 steel attained strengths equal to or greater than the parent material after heat treatment to the 165,000 to 180,000 psi strength level.

MATERIALS:

The weld plates were made from a 1/8-inch thick sheet of annealed SAE 4340 steel. The welds were made using P&H - BA91 welding rod 3/32 inches in diameter.

PROCEDURE:

The SAE 4340 plate was machined and assembled for welding as shown in Figure 1. Welds were made in two passes with a D.C. welding machine employing reverse polarity with 110 amp. setting.

Prior to welding the specimens were pre-heated to 550°F - 600°F with an Ox-Acetylene torch and Tempil sticks were used as the temperature indicators. After welding a post heating cycle was done similar to the pre-heating cycle.

The welded specimens along with three un-welded control specimens were subjected to the following heat treatment in the Material and Processes Laboratory:

a) Normalized at 1600°F for 1½ hours and air cooled
b) Austenitized at 1550°F for 1½ hours and oil quenched
c) Tempered at 800°F for 2 hours, air cooled, and re-tempered at 800°F for 2 hours

Following heat treatment, the welded plates were cut to 1 inch wide strips as shown in Figure 1. The specimens were then straightened to remove heat treat distortion prior to machining. All strips were machined into flat tensile specimens as indicated in Figure 2.

Testing was done in a 60,000 lb. Tinius Olsen Electo-Matic testing machine. A strain rate of 0.001 in/min. was employed to determine the .2% yield strength. After yield, specimens were stressed to failure employing a 0.2 in/min. crosshead speed.

RESULTS AND DISCUSSION:

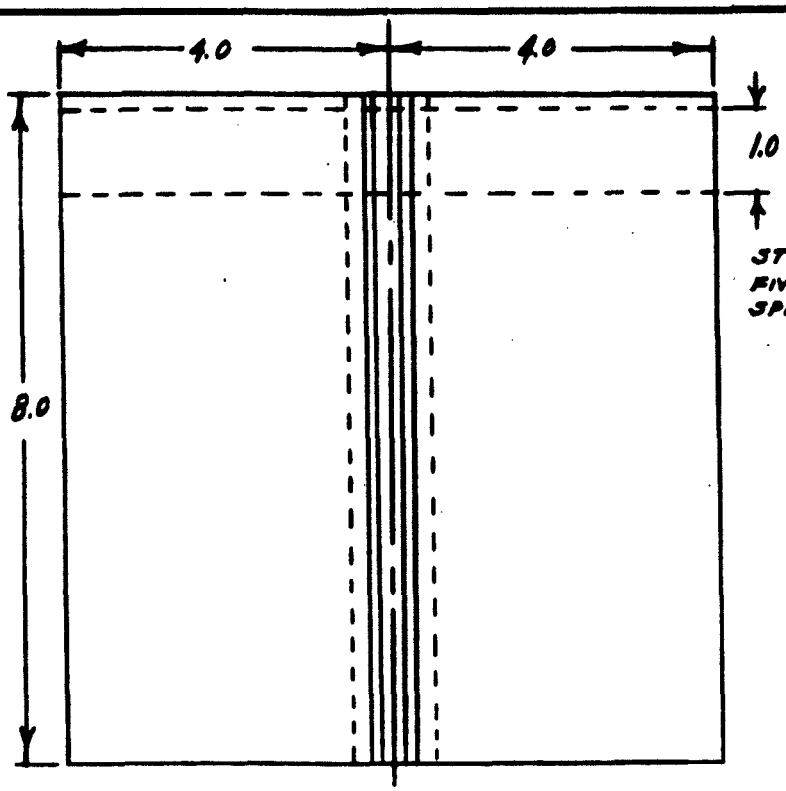
Table 1 lists the mechanical properties of both the welded and un-welded material.

The heat treatment given the material should normally produce ultimate strengths of the order of 180,000 psi. The control specimens did reach this value. On the other hand, the two welded plates fell somewhat short of this, one more so than the other.

In attempting to hot straighten the plates after heat treatment a laboratory furnace was used. Unfortunately the furnace overshot the intended temperature so that the welded plates reached a temperature in excess of 800F for an unknown period of time. This may account for the differences in the values obtained.

In all cases the specimens failed in areas removed from the weld zone for distances of $\frac{1}{2}$ inches or better. This seems to indicate that the welded joints responded to heat treatment as well or better than the parent material.

The data from which this report is written are recorded in Engineering Test Laboratories Notebook #965.



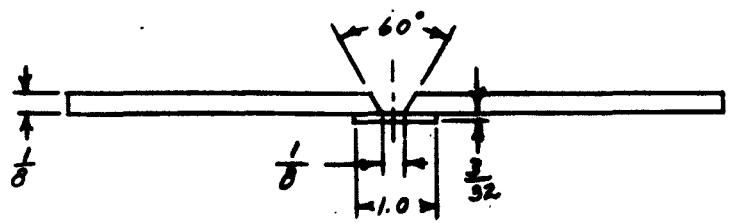


FIG 1 - WELD SPECIMENS 2 MADE

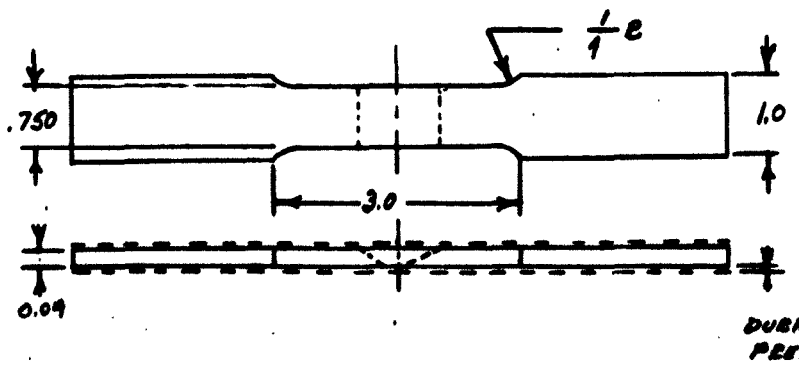


FIG 2 - TENSILE SPECIMEN

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TABLE 3 RESULTS OF TENSILE TEST FOR SAE 4340 WELDED WITH PGH BAG1 WELDING ROD

SPECIMEN NO.		THICKNESS IN.	WIDTH IN.	AREA $IN.^2$	YIELD LOAD LB	YIELD STRENGTH LB/IN^2	ULTIMATE LOAD LB	ULTIMATE STRENGTH LB/IN^2	LOCATION OF FRACTURE	TYPE OF FRACTURE
1	NOT WELDED	0.0902	0.7454	0.0672	11,800	175,600	12350	183,900		45° TO LOAD } DUCTILE
2		0.0902	0.7460	0.0673	11,650	173,100	12200	181.300		" "
3		0.0830	0.7467	0.0620	10600	171,100	11,220	181,000		" "
4	WELDED PLATE #1	0.0741	0.7407	0.0549	9190	167.400	9670	176,100	>¼" FROM WELD	" "
5		0.0685	0.7454	0.0511	8540	167,100	9040	176, 900	>¼" FROM WELD	" "
6		0.0715	0.7511	0.0537	9140	170,200	9580	178,400	>¼" FROM WELD	" "
7		0.0783	0.7541	0.0590	9980	167,200	10520	178,300	>¼" FROM WELD	" "
8		0.0732	0.7544	0.0552	9150	165,900	9750	176,600	>¼" FROM WELD	" "
9	WELDED PLATE #2	0.0722	0.7470	0.0539	8430	156,400	9030	167,500	>¼" FROM WELD	" "
10		0.0767	0.7442	0.0571	8370	146,600	8930	156,400		" "
11		0.0820	0.7491	0.0614	9340	152,100	10140	165,100	>¼" FROM WELD	" "
12		0.0797	0.7490	0.0595	9280	156 000	9950	167,200	>¼" FROM WELD	" "
13		0.0754	0.7504	0.0566	8800	155,500	9460	167,000	>¼" FROM WELD	" "